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Underground Mine Energy Audits
A Case Study

by Andy Mork, PG CHG
Objectives

• Outline energy audit process
• Summarize case study
• Show example Energy Conservation Measures (ECMs)
Why Perform Energy Audit?

Organizational Benefits

• Identify energy use patterns/relationship to production
• Baseline information
  - Carbon footprint
  - Greenhouse Gas (GHG) tracking
• Consolidation of operator knowledge
Why Perform Energy Audit?

Economic Benefits

- Energy conservation measures (ECMs)
- Optimize mining and milling operations

\[= \text{Lower Production Costs}\]
Why Perform Energy Audit?

Establish Key Metric for Your Mine:

*Energy density for mining processes*

$kWHr/Ton$ or $mJ/Ton$
Phase I – Broad analysis of energy use

- Identify major energy-consuming systems
- Quantify energy use by system
- Compare systems to rank energy consumption
Owner Responsibility

• Provide at least one year's utility bills
• Provide production data for same year
• Schedule key mine personnel
• Arrange site walk-through logistics
Consultant Responsibilities

- Assemble qualified, MSHA safety-trained team
- Team members:
  - Utility rate analyst
  - Electrical engineer with mining experience
  - Electrical system studies engineer
  - Project Manager
- Respect Miners time, obey safety regulations
Typical Scope and Schedule

- **Rate Analysis**
  - Duration: 6 weeks

- **Site Reconn**
  - Duration: 6 weeks

- **Report Prep**
  - Duration: 18 weeks
Step 1. Organization – *Owners Tasks*

- Collect utility bills and production data

  *Consultant performs rate analysis*

- Schedule mine staff
  - Technical Leads; electrical and operations
  - Mine Safety rep for Safety Briefing
  - Identify Mine/Mill Tour Guides

- Collect One-Lines and Long Sections
Phase I Energy Audit Case Study
On-Site Activities

Step 2a. Initial On-Site Meeting
- Process Overview
- Rate Analysis Results
- Mine Safety briefing
- Q and A
Phase I Energy Audit Case Study
On-Site Activities

Step 2b. Site Reconnaissance
Mine and Mill Tour

Hoists
Phase I Energy Audit Case Study
On-Site Activities

Step 2b. Site Reconnaissance
Mine and Mill Tour

Dewatering Systems
Phase I Energy Audit Case Study
On-Site Activities

Step 2b. Site Reconnaissance
Mine and Mill Tour

Air Compression and Distribution
Phase I Energy Audit Case Study
On-Site Activities

Step 2b. Site Reconnaissance
Mine and Mill Tour

Ventilation
Phase I Energy Audit Case Study
On-Site Activities

Step 2b. Site Reconnaissance
Mine and Mill Tour

Mill Processes
Step 2b. Site Reconnaissance
Mine and Mill Tour

Power Supply
Phase I Energy Audit Case Study
On-Site Activities

Step 2c. Site Reconn – Close-Out Meeting

• Mine Staff
  - Technical Leads
  - Management
• Present Preliminary Findings
  - Energy Systems Overview
  - ECMs
• Q and A
Step 3. Reporting

- Rate Analysis
- Energy Distribution by System
- Power Quality Study – if data readily available
- ECMs and Cost Savings Detail
- Recommendations for Phase II Audit
Step 3. Report – Rate Analysis

- Examine gas and electricity contracts
- Chart usage for period of record
- Compares usage per ton production
### Phase I Energy Audit Case Study Report: Energy Distribution by System

<table>
<thead>
<tr>
<th>System</th>
<th>% of Total</th>
</tr>
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<tbody>
<tr>
<td>Air Compression</td>
<td>38.1</td>
</tr>
<tr>
<td>Downshaft</td>
<td>32.6</td>
</tr>
<tr>
<td>Ventilation</td>
<td>11.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>81.8</strong></td>
</tr>
<tr>
<td>Mill Processes</td>
<td>8.4</td>
</tr>
<tr>
<td>Hoisting</td>
<td>8.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>16.7</strong></td>
</tr>
</tbody>
</table>

Focus Phase II on:
- Air compression
- Downshaft
Phase I Energy Audit Case Study
Report: Power Quality Study

![Graph showing power quality study results for Phase A-B, Phase A-C, and Phase B-C over a 24-hour period.](image-url)
Low Power Quality Implications

- Inefficient motor function
- Higher heat loads
- Shorter operational life
- Increased maintenance/replacement costs
Typical ECMs - Air Compression Systems

Energy losses due to:

- Leaks
- Lack of valving to isolate unoccupied levels
- Old or inefficient compressors
### ECM Demonstration: Air Leak Losses

<table>
<thead>
<tr>
<th>Leak Dia.</th>
<th>CFM Loss</th>
<th>CF/YR Loss</th>
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</thead>
<tbody>
<tr>
<td>1/64”</td>
<td>0.41</td>
<td>212,809</td>
</tr>
<tr>
<td>1/32”</td>
<td>1.55</td>
<td>849,139</td>
</tr>
<tr>
<td>1/16”</td>
<td>6.5</td>
<td>3,401,798</td>
</tr>
<tr>
<td>1/8”</td>
<td>26</td>
<td>13,628,160</td>
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<tr>
<td>1/4”</td>
<td>104</td>
<td>54,628,160</td>
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<tr>
<td>3/8”</td>
<td>234</td>
<td>122,653,440</td>
</tr>
<tr>
<td>1/2”</td>
<td>415</td>
<td>217,526,400</td>
</tr>
</tbody>
</table>

Source:
ECM Demonstration: Air Leak Loss Cost Estimate

• Est. Leak Size 1/32” (1.55 CFM @ 100 psi)

• Cost for one leak = $163/year (@ $0.20/1,000 cfm)

• Annual Cost of 1,000 leaks = $163,000/year

• Cost for one leak 1/16” = $663/year (@ $0.20/1,000 cfm)

• 1,000 Leaks @ 1/16” = $663,000/year

Note: 1. Costs will vary depending on electrical rate
ECM Demonstration: Motor Operation

Alternative cost comparisons¹

- Variable frequency drives

- Soft starters on large induction loads

Note: 1. Could be proposed as part of Phase II scope
ECM Demonstration: Lighting

- 75 Watts incandescent vs 15 Watts per CFL
- 2,000 bulbs @ 8,760 hrs
- Savings $52,000/year (will vary with electrical rates)
- Incandescent life span 750 – 1,000 hours
- CFL life span 6,000 – 15,000 hours
- Labor costs savings for CFL vs. incandescent replacements—significant!
• Mines on grid: May consider using renewable energy generation sources

• Mines off grid: May consider using more efficient conventional or renewable energy generation sources
Thanks!

Questions?

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